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ASTRONOMICAL AND HISTORICAL
CHRONOLOGY

W. LEIGHTON JORDAN

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1. The first part of the document is a list of names and titles, including the names of the authors and the titles of the works. This list is organized in a table format with three columns: the first column contains the names of the authors, the second column contains the titles of the works, and the third column contains the names of the publishers or the names of the institutions that published the works. The list is organized in alphabetical order by the names of the authors.

ASTRONOMICAL AND HISTORICAL CHRONOLOGY

IN THE BATTLE OF THE CENTURIES

BY

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FELLOW OF THE ROYAL INSTITUTION OF GREAT BRITAIN; FELLOW OF THE

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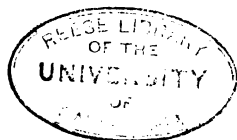
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PREFACE

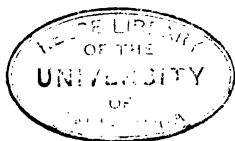
THE following Argument (excepting the references to the State Library of Venice and to the 1875 edition of Bond's 'Chronology') was written in the year 1900, when discussion was rife as to whether that year properly belongs to the nineteenth or to the twentieth century; and I have retained it as a basis for argument, as it sometimes simplifies references and discussion.

I have used the term *historical* rather than the usual term *vulgar* chronology in the title because the origin of the latter term makes it properly include astronomical chronology, it having been intended to signify that it does not give the true number of years from the Annunciation or from the Nativity. And also 'historical chronology' was a technical term for the Christian era used with Julian years before the Gregorian Reformation, which identified vulgar chronology with it, so that my present use is, in fact, the original use of the term.

ROYAL INSTITUTION, ALBEMARLE STREET, LONDON :
April 2, 1904.

TABLE I.

Year of Rome A.U.C.	Historical (or 'Vulgar') Year	Astronomical Year	Florentine and St. Augustine's Year	Pisan and Dionysian Year. The method of Dionysius Exiguus, the originator of the Chris- tian Era
752	2 B.C.	1 B.C.	1 B.C.	1 B.C. or 1st
753	1 B.C.	0	0	1 A.D. " 1st
754	1 A.D.	1 A.D.	1 A.D.	2 " " 2nd
2653	1900	1900	1900	1901 " " 1901st
The Gregorian Reformation made 1900 A.D. identical with 2653 A.U.C., as reformed by Cæsar.		<p>Always used in England for A.D. years: 'Anno ab incar- natione Domini.' (See p. 12.)</p> <p>Formerly preva- lent in France as well as at Pisa and some other parts of Italy, but not at Florence; and written in or- dinal numbers: 'Anno incarnationis Dominicæ.'</p>		
The Astronomical numbering of the B.C. years must have been that of both Florentines and Pisans.		<p>The erroneous numbering of the B.C. years in vulgar chronology cannot have existed until long after the invention of the Christian era.</p>		



ASTRONOMICAL AND HISTORICAL CHRONOLOGY

ASTRONOMERS call the year which immediately preceded 1 A.D. the year 0; but in historical chronology that epoch year of the astronomical system is called 1 B.C.

The purpose I have before me is to show reason for such a reformation of historical chronology as to bring it into accordance with the method of numbering the years B.C. which has been adopted by astronomers.

Besides the question as regards the method of using figures for numbering the years, there is a minor difference between astronomical and vulgar reckoning due to the astronomical days commencing at noon twelve hours after the commencement of the day by vulgar reckoning. As regards that minor difference, Sir John Herschel has advocated a reform of the astronomical method for the purpose of making it agree with the vulgar method; and if the astronomical world to whom he appealed should decide on that reform jointly with the reform of historical chronology which is the subject of this paper, then the two methods

of reckoning would agree as regards the enumeration of both days and years.

Sir John Herschel, being himself an astronomer, fully recognised the inconvenience which would be caused by having to record astronomical observations for the same night under two different dates, but he nevertheless declared uniformity of nomenclature and modes of reckoning to be of such vast and paramount importance as to outweigh every consideration of technical convenience or custom.¹

The impracticability of changing vulgar chronology on that point makes a reformation of the astronomical system, as regards it, the only way of arriving at uniformity.

That reform, suggested by Sir John Herschel, is, however, a distinct and subordinate question; and that which I advocate can be more easily effected, and is, in fact, quite independent of the reform suggested by Sir John Herschel.

My argument will be found to be to the effect that the astronomical method of placing a zero year between the B.C. and the A.D. years is intrinsically superior to the historical system, which places 1 B.C. and 1 A.D. in juxtaposition; and that, in fact, when the existing enumeration of the years of the Christian era was arranged the year which is now the zero year of astronomers was regarded as the first or epoch year of the era, and the enumeration of 1 A.D. was purposely given to what was then recognised as the second year of the era. And, therefore, when astronomers found it expedient to push back the numbers of the B.C. years, by

¹ *Outlines of Astronomy*, p. 87, 1849. (London: Longmans.)

treating as zero what had become in historical chronology 1 B.C., they unconsciously re-adopted the enumeration of years B.C. which was originally adopted tacitly, if not explicitly, by the Benedictine monks who founded the era.

My argument shows that through a misunderstanding on the part of comparatively modern historians they treated as 1 B.C. the year which when the era was first established was called 1 A.D. by those who used ordinal, and the year 0 by those who used cardinal, numbers ; and that the manner in which the centuries are now generally considered to be divided is therefore erroneous.

For an exposition of the questions involved historically and scientifically in this subject some brief references to the writings of Sir John Herschel, Dr. Lardner, and some others, will suffice not only to represent what have been prevalent ideas, but also to create a basis for the establishment of some facts of which they appear to have had no knowledge.

Herschel says that 'in the historical dating of events there is no A.D. 0. The year immediately previous to A.D. 1 is always called B.C. 1'; and the years 'are denominated *as years current (not as years elapsed)* from the midnight between December 31 and January 1 immediately subsequent to the birth of Christ.'¹

He further says that 'the designation of a year by A.D. or B.C. is to be regarded as the *name* of that year, and *not as a mere number uninterruptedly designating the place of the year in the scale of time.*' He says : 'The

¹ *Outlines of Astronomy*, by Sir John Herschel, pp. 628, 629. 1849. (London.)

scale of A.D. and B.C. is not continuous, the year 0 in both being wanting; so that (supposing the vulgar reckoning correct) our Saviour was born the year B.C. 1.¹

Dr. Lardner says that 1 A.D. is the year of Rome 754; and that 'the first year of the Christian era is not, as might be imagined, that of the birth of Christ, but the following year. It is the year in which, according to Dionysius Exiguus, Christ completed his first year.'²

Though Dr. Lardner is correct in those statements, they nevertheless show that he did not know that before the Gregorian Reformation the ordinal numbers applied to the years by Dionysius were discarded for cardinal numbers, so that 1 A.D. became applied to what was recognised by the advocates of both systems to be the second year of the era and had in fact been called 2 A.D.

According to the Benedictine records, Dionysius did not make the mistake of calling the year of Rome 753 the year 1 B.C. That error has been introduced subsequently by others not so conversant as he was with what were then supposed to be, and were accepted as, the facts of the case. What Dionysius called 1 A.D. began on March 25, 753 of Rome, and ended with March 24, 754 of Rome,³ and his method was adopted in Pisa, while at Florence and by St.

¹ *Outlines of Astronomy*, by Sir John Herschel, p. 636. 1849. (London.)

² *Common Things Explained*, by Dr. Dionysius Lardner. 1856. (London.) *The Almanack*, p. 6.

³ *L'Art de Vérifier les Dates*, par un Religieux Bénédictin de la Congrégation de S. Maur; vol. i. p. v., troisième édition. 1788. (Paris.)

Augustine in England the following year was called 1 A.D. The Benedictines record that position of the question as indisputable, and it is confirmed by the fact that in the twelfth century our present method of calling the year of Rome 754 the year 1 A.D. did not universally prevail even among those who used for the new era the Julian year commencing on January 1, in conformity with the year of Rome. By them the years of our era were numbered so as to make the year of Rome 753 identical with the year 1 of our era, so that the same year which we call 1102 A.D. was by them called 1103 A.D.¹ They did not change the day for the commencement of the year, but merely substituted 1 A.D. for 753 A.U.C. It is not any difference of opinion as to which is the epoch year of the era, but merely the difference between using cardinal instead of ordinal numbers that has changed the above-mentioned date from A.D. 1103 to 1102; and a peculiarity of the position is that in consequence of the epoch year having become erroneously called 1 B.C. the cardinal numbers used by the Florentines are now supposed to be ordinal numbers, as stated by Sir John Herschel, whereas in fact it was those who differed from the Florentine method of applying figures to the years who used ordinal numbers, while those who followed the Florentine enumeration, which has become universal, used the figures as cardinal numbers. If the Dionysian enumeration had been maintained the present year would have been A.D. 1901, but the substitution of the Florentine method has made it A.D. 1900.²

¹ *L'Art de Vérifier les Dates*, pp. iv, viii, and ix.

² See Preface.

The records of which I shall now give some examples place the historical accuracy of the foregoing beyond the reach of dispute.

The two phrases *Anno ab Incarnatione Domini* and *Anno Incarnationis Dominicæ* seem to have been used at times promiscuously before the abbreviation A.D. came into use; but they clearly represented originally the two different systems of numbering the years, the former being used with the cardinal and the latter with the ordinal numbers.

A charter signed by King Robert II. of France, dated 'Anno Dominicæ Incarnationis MXXVIII,' is shown to belong to the year 1027 A.D. according to the now prevailing method of numbering the years.¹

Another charter signed by the same king, dated 'Anno Incarnati Verbi millesimo,' is shown to belong to the year 999 A.D.² according to the Florentine system, which has now completely displaced the ordinal enumeration used by Dionysius.

And the date of King Robert's death, which occurred on July 20, 1031 A.D., is recorded by the historian Helgaud as 'Anno qui est Incarnationis millesimus tricesimus secundus.'³ That clearly declares what we call 1031 A.D. to be the 1032nd year of the era.

A Strasbourg date is recorded as 'Anno Incarnationis Dominicæ milesimo quinto,' and is shown to be applicable to the year 1004 according to our present system⁴; and it has been therefore inferred that the document must have been signed between Christmas Day and January 1, between which dates there was

¹ *L'Art de Vérifier les Dates*, p. v.

² *Ibid.*

³ *Ibid.*

⁴ *Ibid.* p. ix.

often confusion as to which year was current. But, whatever may have been the fact in that special case, it seems clear that such a date as Anno Incarnationis Dominicæ *quinto*, used under the Pisan system, was originally recognised as equivalent to Anno ab Incarnatione Domini *quatuor* (not *quinque*) used under the Florentine system; the ordinal number *quinto* designating the same year as the cardinal number *quatuor*.

A charter signed in a monastery near Reims, and dated 'anno Domini, secundum cursum Ecclesiæ Remensis MCCCXC, decima tertia die mensis Junii,' is shown to belong to the year 1389 A.D. by our record.

King John's submission to Pope Innocent III. is dated 'on the third day of October in the year from the incarnation MCCCXIII.,'¹ and the number of the year accords with the Florentine system, which has always prevailed in England.

A charter granted by Athelberht, King of Kent, and with the granting of which St. Augustine, then Archbishop of Canterbury, appears to have been connected, is dated 'in the City of Canterbury, anno ab Incarnatione Christi, DCV.'² In the absence of any suggestion to the contrary, I presume that the enumeration of the year 605 accords with our present usage.

The Benedictine work from which I have already quoted does not mention any use of the Pisan enumeration in England; it says (p. x.): 'Le calcul Pisan, qui précède d'une année entière celui de Florence, a

¹ Arbutnot, *The Mysteries of Chronology*, p. 49.

² *Rules for Verifying Dates*, by John J. Bond, Assistant Keeper in her Majesty's Record Office. 1875. (London.)

été en usage, non seulement à Pise, mais à Lucques, à Sienne, à Lodi; plusieurs Papes s'y sont conformés dans les dates de leurs Bulles, et plusieurs Empereurs d'Occident, dès le IX^e siècle, dans celles de leurs diplomes.' They have, however, as above shown, proved its use in France.

Dr. Lardner says: 'Dionysius made historical researches, the result of which assigned the birth of Christ to the 25th day of December, in the 753rd year from the foundation of Rome'; it appears to me, however, quite clear that Dionysius deliberately preferred to make the era commence with the first year of one of his cycles of 532 years (consisting of twenty-eight lunar cycles of nineteen years) rather than with the records which he must have known make 4 B.C. of the vulgar era the first year. Bond,¹ after pointing out that the Golden Number 1 of the Dionysian reckoning falls to the year known as 1 B.C., says: 'But as that year did not come within the range of the Roman reckoning, the number 1 of the first cycle of 532 years was represented by 0.' And then he adds: 'Hence arose a system by which the *annus verus*, or 4 B.C., was called by ecclesiastical writers 3 B.C., by the omission of 1 B.C. marked 0, and thus great confusion has been caused when calculations have been made subject to that erroneous system.'

I do not know what authority Bond has for the fact of the zero year having been used as he states, but I have no doubt as to the accuracy of any such statements in his valuable work; the tenour of my argument is, however, all to the effect that he has not properly

¹ *Rules for Verifying Dates*, George Bell & Sons, 1875, p. 321.

appreciated the action of those who used it as he states. His allusion to the comments on the absence of a year 0 which were made by Sir John Herschel (who evidently did not know of such an enumeration ever having been used) show that he considers the method adopted by astronomers to be an erroneous system of enumeration, and make it appear to me that he misunderstood the object of Herschel's comments.

In the article on Chronology in the 'Encyclopædia Britannica'¹ W. L. R. Cates makes some contradictory statements. He says the Christian era commenced on January 1 in the 753rd year from the foundation of Rome, meaning, I presume, 753 A.U.C., as, though 753rd might be applied to 752, it cannot be applied to 754, A.U.C., which corresponds with 1 A.D., and, so interpreted, that statement agrees with the further statement he makes (in direct contradiction to Herschel) to the effect that the years of the Christian era are distinguished by the cardinal numbers. He, however, not only does not comment on the fact that those statements make the year 1 A.D. the second year of the era, and are incompatible with the application of the name 1 B.C. to the year of Rome 753, but also he himself further on treats 1 A.D. as the first of our era and the preceding year as 1 B.C., regardless of the fact that those statements directly contradict his previous statements that the numbers are cardinal and that 1 A.D. commenced with the 753rd year of Rome. His statement that the era commenced on January 1 of the 4714th year of the Julian period also makes 1 A.D. the

¹ Ninth edition, vol. v. p. 712.

first of the era. The 'Encyclopædia' truly reflects the confusion of ideas which has existed.

The fact is that the Gregorian Reformation has virtually made the era commence with January 1, 753 of Rome, reverting to the method of those who, as already stated, applied the term 'year of the Incarnation' to the years of Rome commencing on January 1, treating the first year of the Incarnation as the year 753 of Rome, on the same principle as a year A.D. might be referred to as the first of a king's reign and the following year A.D. as the second of his reign, so that he might be recorded as in the second year of his reign after reigning a few months, or even a few days.¹ By reverting to that principle the Gregorian Reformation got rid of the confusion created by the change from the Julian to the Christian year. But that was not the commencement of the year in the 'year of the Incarnation,' which was the original Christian era, and was introduced into England by St. Augustine in the sixth century, soon after its invention by Dionysius²; but St. Augustine appears to have used it with the Florentine instead of the Dionysian enumeration. It was, I understand, considered to commence with what is now termed Lady Day, or the Feast of the Annunciation, March 25 of the year of Rome 753. At any rate, Dionysius called the year commencing on that date the year 1, and St. Augustine's introduction of the Florentine enumeration into this country resulted in the

¹ 'Elagabalus reigned three years and nine months of solar years, and yet we have coins dated in his fifth year.' Bond, *Rules for Verifying Dates*, 1875, p. 23.

² *L'Art de Vérifier les Dates*, vol. i. p. ili.

year 1 A.D. becoming recognised as commencing on March 25, 754 A.U.C. Statements by accurate authorities are sometimes apparently contradictory merely in consequence of two different years being used at the same time in the same country, so that both may be true though each ignores the existence of the system differing from that recorded by him. According to Bond's 1866 edition of the work quoted on page 14, the year of the Nativity was in use in England at the time of the Norman Conquest, and the Julian year was then introduced by William I. and continued to be used for about 100 years, when Henry II. substituted the year of the Incarnation. His 1875 edition, however, recognises the latter year as having been the first used in England, and the French work I have quoted is very explicit as to the years of the original era of the Incarnation having commenced on March 25; and adds that after A.D. 744 and the time of Charlemagne French historians who used the years of Jesus Christ did not all agree as to the commencement of the year. It is also pointed out that Gregory of Tours confounded the era of the Incarnation with that of the Passion, and that is perhaps the original source of much subsequent confusion. The year of the Nativity appears by the French work (p. x) to have been first used in England in the seventh century. And, in the thirteenth century, Gervais of Canterbury asserted that it had been used by nearly all English writers who had preceded him '*pour la raison que ce jour est comme le terme où le soleil finit sa course et la recommence.*' The general tenour of the Benedictine work shows them to have considered it clear that

(except some adherence to the Julian year) no year but that of the Incarnation was used with the vulgar Christian era until some time after the date of its introduction into England. The question as to whether St. Augustine used the year of the Nativity or that of the Incarnation is not, however, material to my main argument. St. Augustine was a Benedictine, and was educated by Gregory I. before the latter became Pope. Gregory, however, does not appear to have used the Christian era at all, as the first recorded use of it by any of the Popes is in 613 A.D. by Boniface IV., fifteen years after St. Augustine's arrival in England, and whatever may be proved to be the method adopted by either will probably have been the one used by the other. As St. Augustine was a Benedictine, it seems natural that he should have used the year of the Incarnation commencing on March 25, but it is remarkable that the Pisan enumeration had apparently been abandoned by him in favour of the Florentine.

In connection with the foregoing argument it is expedient to record that the most recent of writers on chronology, F. F. Arbuthnot,¹ on the authority of Father Hardouin, expresses doubts as to any such person as Dionysius Exiguus having existed; but the fact of the invention of the Christian era remains indisputable, and no reason is shown why the Benedictine traditions should not have handed down the name of the originator of the era. If the legend of Dionysius is rejected, it can only be said that the era was invented by some Benedictine monks whose

¹ *The Mysteries of Chronology*, by F. F. Arbuthnot, pp. 18-22. 1900. (London.)

names have not been handed down to posterity, and the foregoing argument remains unaffected; for if Dionysius is not the name of an individual who made a special study of the subject, it serves the purpose of representing the group of Benedictines who originated the era.

Arbuthnot, like Herschel, Lardner, Playfair, and others, treats the year 1 A.D. as the first year of our era¹; but the erroneous name, 1 B.C., given to the year of Rome 753, which immediately precedes it, seems to be the only reason for doing so. Having treated the year 753 of Rome as 1 B.C., they could not logically regard the year next following it as the *second* of the Christian era, though the 'Encyclopædia Britannica,' as above shown, disregards logic in the question; for, as already shown, it declares the figures we use to be cardinal numbers, and that the year 753 A.U.C. is the first of our era, directly contradicting Herschel on those two points, but it immediately afterwards joins with Herschel by treating 1 A.D. as the first of the era and declaring the preceding year to be 1 B.C., thus making both those figures ordinal numbers and making 753 A.U.C. the same as 1 B.C.

In 'Macmillan's Magazine' for February, 1900, a writer signing 'Dionysius Minimus' says that he finds it recorded, on the authority of the Astronomer Royal, that it has been agreed in chronology to call the first year of the Christian era 1 A.D.; and that it also appears that there are in existence two letters of Dionysius which prove that arrangement to have been his deliberate intention; but the facts I have recorded

¹ *The Mysteries of Chronology*, p. 7; see also pp. 16, 17.

above show that though it is true that Dionysius called the first year of the era 1 A.D., the year so named by him is that which became in vulgar chronology called 1 B.C., and what the Florentines called 1 A.D. was called by him 2 A.D. We apply to the years of the era the same figures as the Florentines applied to them respectively, but we erroneously treat them as ordinal numbers, though the figures applied by Dionysius, which really represented the ordinal numbers, were always one figure in advance of the Florentine figures, which latter are the figures of all our now existing records of dates.

A question which must force itself upon the attention of anyone who considers the foregoing circumstances is as to why (excepting the minor difference as to commencing at noon or at midnight) there should be any difference between astronomers and other chronologers in the system of recording historically the dates of events. It certainly cannot be disputed that the astronomical system is a reasonable and correct method. If by that method an event occurred in the year 100 B.C. and another event on the corresponding day in the year 100 A.D., the lapse of time between them is 200 years; whereas under the vulgar system one year must be deducted after adding the dates together to get the correct number of years between the two events. So also for reckoning leap years the same rules apply under the astronomical system for the dates B.C. as for those A.D.; whereas under the vulgar system the rules which apply to the dates A.D. do not apply to those B.C. On the other hand, the vulgar method does not seem to have any advantage over the

astronomical method. Why should that confusion of systems be persisted in?

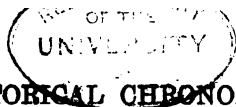
The authorities who established the era treated it as if they supposed Christ to have been born in the year of Rome 753, and, therefore, in treating that as the epoch year of the scale of time, and numbering it the year 0, and the year preceding that 1 B.C., astronomers merely comply with what were accepted as historical facts when the era was adopted.

Admitting that the year of Rome 753 is not really the year in which Christ was born, but that it is expedient to adhere to the date which was accepted for the establishment of the epoch based on that event when the era was invented, the year of Rome 752, which is in vulgar chronology called the year 2 B.C., is correctly called by astronomers 1 B.C.; and the year of Rome 753, which in vulgar chronology is called 1 B.C., is the epoch year of the Christian era, and is correctly called by astronomers the year 0.

A misconception of the principles on which an epoch for the record of events ought to be based seems to be the only explanation for the epoch year having been omitted when historians first numbered the B.C. years in vulgar chronology; and its omission creates an error in the record of time identical with that which would be created by the omission of the unit cipher between the teens and the twenties or between the twenties and the thirties. By passing from 29 to 31, ignoring the cipher of the thirties, a correction, by deducting one year from every date, would for ever afterwards be necessary to get a true record of years elapsed; and the cipher year of the forties would have

to be reckoned as belonging to the thirties in order to keep the ten-year periods equal, though in the absence of the erroneous omission of the year 30 the year 40 would arithmetically belong to the series of the forties, because it would signify that forty years of the era had elapsed, not that the 40th year was current. The error appears to be due to the consecutive framers of the vulgar era, as now constituted, not having always recognised that a zero year is requisite for its commencement, to divide the A.D. from the B.C. years, just as a zero is arithmetically requisite between each separate group of integral units. That error is avoided by astronomers and was not made by those who gave to the A.D. years the numbers now in use, but was made subsequently by those who numbered the B.C. years. To use Sir John Herschel's phrase, chronologers have been driven to the expedient of 'calling the years *names*,' instead of counting them mathematically, in consequence of the erroneous omission of the zero year between the B.C. and the A.D. years.

Sir John Herschel says, in one of the above extracts, that the year 0 is wanting in the A.D. as well as in the B.C. part of the scale of years. The fact, however, is that it is because we do not know where the true origin is that we have to create a fictitious origin; and it would be as great a mistake to constitute two zero years, one for the B.C. scale and another for the A.D. scale, as that made by the total omission of the zero year in vulgar chronology. The astronomical scale as at present constituted is all one scale with a perfect arithmetical sequence throughout; the years in one



direction from zero being virtually *plus*, and those in the other direction *minus* quantities ; and the arithmetical sequence is not affected by the position selected for the zero. The zero of astronomers is in fact the zero year of time transferred to an artificial position arbitrarily determined ; and wherever placed it is the zero of all years, whether B.C. or A.D. The year of Rome 753 was the chosen epoch year when our era was founded, and it properly belongs to the first century of the era based upon it wherever that century may be in the absolute scale of time ; so that the year of Rome 853 was the first year of the second century of our era, not the last of the first century. The calling of the year of Rome 753 the year 1 B.C. after having made 1 A.D. represent the year of Rome 754 is an error to which astronomers cannot reasonably conform, as that number arithmetically belongs to the year of Rome 752, and is correctly applied to it by astronomers ; and as we are now (November 1900) in the year of Rome 2653, we are therefore in the first year of the twentieth century of years in the Christian era. If the year of Rome 753 really were the year 1 B.C., as in vulgar chronology it is now erroneously called, then we should not be in the twentieth century of the Christian era until next year (A.D. 1901) commences.

It is because Sir John Herschel makes the Christian era commence with the year following what historians call the year 1 B.C. that he says, as above stated, that the dates represent years *current*, not years *elapsed*. But as that year is properly treated by astronomers as the year 0, and is in fact the epoch

year of the Christian era, the numbers as at present applied to the years A.D. do in fact represent years *elapsed* in the Christian era, not years current, as declared by Herschel on the supposition that the erroneous name 1 B.C. given by modern historians to the epoch year puts that year out of the era.

Avowedly knowing the year of Rome 753 to be determined on for the epoch year of the vulgar era, in contradistinction to what must have been known to be the true era, the Florentines seem to have deliberately rejected the enumeration of 1 A.D. which had been applied to it under the Pisan system, and to have termed the year of Rome 754 the year 1 A.D., because in cardinal enumeration the first year of the era is the zero of years, and the second year is the first in which a complete unit of years can be counted. At any rate, the adoption of their method by modern astronomers shows that they took the correct course in fixing 1 A.D., and the further evidence I have cited shows that though Dionysius used ordinal numbers to represent the years of the era, that method was gradually rejected in favour of cardinal numbers, making what was recognised as the second year of the era 1 A.D.

It is mere matter of fact that the ordinal enumeration, first, second, third, &c., does not correspond with the common arithmetical (or cardinal) enumeration, one, two, three, &c., respectively, but with the arithmetical index figures, 0, 1, 2, &c., respectively. The arithmetical index figure 1 cannot appear in the scale of time in which years are the units, until what is in ordinal enumeration the first year is passed.

Though the idea of treating zero as a number does

not appear to have been entertained by ancient mathematicians,¹ 0 is now acknowledged to be the first number, and is, therefore, also the first figure in arithmetic, and 9 is the 10th.

Confusion has been created by the imperfect or contradictory ideas of enumeration which formerly prevailed. Archimedes represents the numbers 1 to 9 by letters of the Greek alphabet, but does not give a letter to represent zero. It is only more recently that the cipher was brought into arithmetic as a tenth figure; and still more recently mathematicians have realised the fact that zero must be regarded as a *number*; and its acceptance as such gives the cipher, which was previously treated as the tenth figure, the position of the first number, and, therefore, that of the first figure, and makes the position of tenth figure still given to it in text-books a survival from the erroneous theory which formerly excluded zero from the category of numbers.

Sir John Herschel's remarks show that he recognised that in vulgar chronology the years are now considered to be reckoned by ordinal numbers, both B.C. and A.D., and that such a system is unsuitable for the measurement of time. But his comment as to the absence of a year 0 in the A.D. scale shows that he supposed that though the years B.C. are reckoned in the astronomical scale by cardinal numbers representing years elapsed (counting backwards), those of the A.D. scale are reckoned in ordinal numbers representing years current. He evidently regarded the A.D. and the B.C. years as belonging to two separate scales. But

¹ *Century Dictionary*.

the astronomical scale of time is in fact all one continuous scale, and as such cannot have more than one zero year upon it. It would, as above said, be as great a mistake to put in two zero years as to leave the zero out altogether.

A foot rule measures the same distance whether it is turned with the enumeration of the inches running from left to right or from right to left. Suppose, for the sake of illustration (the epoch inch, like the epoch year in the astronomical scale, being treated as zero), the beginning of time to be found at any point of time—say, exactly at 4713 B.C. (the moment that figure leaves the vulgar scale as an ordinal number and appears on the astronomical scale as a cardinal number). Then the B.C. part of the scale might be inverted; and the zero year of the Christian era would take its proper place as the zero year of the complete scale of time, the number 4713 being substituted in its place so that 4714 would remain identical with 1 A.D., and, as at present numbered, the A.D. years, at any date, added to the B.C. period of 4713 years would give the correct measure on the scale of time; but to do so the numbers, both A.D. and B.C., must of necessity represent cardinal numbers recording years elapsed, not years current. The year 0, which was the enumeration of the first year of the old era, continues to be that of the first year of the new era. It is the zero of all years wherever it may be placed. If a second zero year had been added specially for the A.D. part of the scale then the present numbers would be pushed forwards, 1 A.D. taking the place of 2 A.D., and the mistake made by the insertion of the second zero year would have to be

corrected by always adding one year to the date to get the true position on the scale of time.

The admission of a single zero year makes the figures in both directions from it cardinal numbers and the absence of a zero year, as in the vulgar scale, makes them ordinal numbers in both directions. Those ordinal numbers were rejected by the Florentines; and not only have modern astronomers re-adopted the Florentine system, but also Sir John Herschel expressly declares ordinal numbers to be unsuitable for the scale of time.

As a question of pure theory the astronomical system is the only correct method of recording time on a single scale. One zero year only can appear on the scale, and that must of necessity be the first year of the era; the years which follow it being *plus* quantities and those which precede it *minus* quantities. The difference between *plus* one year and *minus* one year is two years, which is correctly shown in the astronomical scale; but the vulgar scale makes the difference only one year instead of two years, and the suggested additional zero year for the A.D. years would make such a scale show a difference of three years instead of two years. I must repeat that not only does theory require the first year of any era to be enumerated by the index figure 0, but also the year 0 of astronomers is in fact the original epoch year of our era, and as such was numbered by Dionysius the year 1 as he used ordinal enumeration, and the figures as now applied in the subsequent cardinal enumeration of the years A.D. do in fact represent years elapsed, not years current.

Though not material to the main purpose of my argument, it is nevertheless of interest to record the opinions of leading authorities as to what was the date of the birth of Christ.

Some students of the question argue that a conjunction of the planets Jupiter and Saturn which occurred in the year of Rome 747 (the vulgar 7 B.C., or astronomical 6 B.C.) formed the Star of Bethlehem, and thus make that the true epoch year; while others suggest that the first of two comets recorded by Chinese astronomers in the years of Rome 749 and 750 respectively makes the first of those two years the true date, which by the astronomical record would be 4 B.C. or by the vulgar record 5 B.C. This latter is the date accepted by James Playfair.¹ He, however, alludes to it as 'about four years prior to the date of the vulgar Christian era,'² professing himself unable to decide as to whether the event occurred towards the end of 748 or in the middle of 749 of the years of Rome. His argument is to the effect that an eclipse of the moon which occurred on March 13, 4 B.C. (astronomical 3 B.C.) fixes that year, which is 750 A.U.C., as the date of the death of King Herod the Great; and that 'it is highly probable' that Christ was born 'not much more than a year before Herod's death.'

Playfair incidentally refers to Dionysius as having 'adjusted' the first year of the Christian era to the

¹ *A System of Chronology*, by James Playfair, D.D. Edinburgh, p. 260. 1784.

² *Ibid.* p. 50. The 'era of Jesus Christ' was at one time used with the numeration commencing with 4 B.C. of the Vulgar era, thus agreeing with Playfair's argument.

4714th of the Julian period,¹ though the fact is that the so-called Julian period or cycle was invented by Scaliger (as Playfair of course knew) only in the year 1582 A.D. (the year of the Gregorian Reformation) for the concordance of various cycles of which it is a common measure, and March 25, 4713 (not 4714) of the Julian period corresponds with the commencement of the year 1 as fixed by Dionysius. If, as stated by Playfair, Dionysius invented the Christian era about the year 527 A.D., his so-called adjustment was with the years of Rome; and March 25, 527 A.D. (termed by him the 528th year of the era) was March 25, 1280 of Rome; but his work was not one of adjustment, but of disturbance, for he took the above date instead of January 1 as the commencement of the year. The adjustment was effected by the Gregorian Reformation (in 1582 A.D.), which made the year 1280 of the Roman era (A.U.C., or Anno Urbis Conditæ) identical with 527 A.D. by making the Christian years commence, like the Julian years (which were the years of the Roman era) on January 1.

Playfair also refers to the Incarnation as if representing our Christmas Day instead of our Lady Day, and that confusion of the origin of the era of the Incarnation seems to have become general. The Benedictines say of the year :

‘Plusieurs la commençoient sept jours plutôt que nous, et donnoient pour le premier jour de l’année le 25 Décembre, qui est celui de la naissance du Sauveur. D’autres remontoient jusqu’au 25 Mars, jour de la Conception, ou de son Incarnation dans le sein de

¹ *A System of Chronology*, p. 50.

la Vierge, communément appelé le jour de l'Annonciation.'¹

The year 4 B.C. of vulgar reckoning is now generally accepted as the date of the birth of Christ, though according to the researches of Playfair just mentioned it may have been 5 B.C., or perhaps 6 B.C. The framers of the vulgar era must (as I have already stated) have known at least as well as we now do what was the true era if commenced from the birth of Christ. That generally accepted date, 4 B.C. vulgar or 3 B.C. astronomical, makes the year 1900 the fourth year of the twentieth century of years from the date of that event ; for if we counted from that year, treating it as the epoch year, and the year which follows it as 1 A.D., the year 1900 would be counted as 1903, or the 1904th year of the era. And if the Dionysian estimate, which brings the event nearer than any other to our time and forms the basis on which the era was founded, be accepted subject to the Gregorian Reformation, nineteen complete centuries of years had elapsed in the era when the year 1900 commenced, making that year therefore the first in the twentieth century.

It must of course be borne in mind that every new era which has been invented has given to all preceding events dates which were unknown when the events occurred. An eclipse of the moon which occurred in the year of Rome which Dionysius supposed to be that of the Incarnation and of the birth of Christ is now recorded as having occurred on January 11 of the year 0 of the astronomical scale, which is identical with the year of Rome 753 excepting the difference of six hours

¹ *L'Art de Vérifier les Dates*, p. iv.

which Herschel has suggested ought to be reformed in the astronomical scale. Since the commencement of that year a complete cycle of the seasons, winter, spring, summer, and autumn, had occurred 1900 times when the month of January 1900 commenced; and we therefore, on January 1, 1900, entered on the twentieth century of cycles of the seasons in the Christian era according to both the Florentine (or St. Augustine) and the Pisan (or Dionysian) methods of counting combined with the Gregorian Reformation, which made the Pisan year 1 and the Florentine 0 identical with the year 753 A.U.C.

Twice since the foundation of the Second Babylonian Empire by Nabonassar, who reformed the previous chronological system with the assistance of Egyptian astronomers, the vulgar record of years has been subjected to further reformation for the purpose of correcting its divergence from the true record of the seasons. The year of Nabonassar, consisting of exactly 365 days, was used in the era of the Romans until the time of Julius Cæsar, when, in order to correct an accumulated error due to the vulgar years being shorter than true years, Cæsar ordered that the year of Rome 708 should last for 445 days, making the year 709 commence with the first new moon which occurred after the winter solstice of the previous year; and the intercalation of days was so arranged as to make January 1, 709 A.U.C., coincide with that new moon.¹ At the same time, to prevent a recurrence of

¹ Bond, on pp. 322-323 of his 1875 edition already quoted from, gives a table of corresponding years of the Julian era and the years of Rome. His table, however, ignores the years of the Roman era as

the error which was corrected as above shown, Cæsar, under the guidance of Sosigenes of Alexandria, ordered that every fourth year should consist of 366 days, so as to make the average length of the year $365\frac{1}{4}$ days; but whereas the year of Nabonassar is nearly a quarter of a day shorter than a true year, the Julian year of 365 days and 6 hours is slightly longer than a true year, the length of the astronomical year on which the seasons depend being 365 days 5 hours 48 minutes and 46 seconds approximately. Cæsar and Sosigenes doubtless knew their year to be inexact, but considered that the necessary correction might be trusted to the intelligence of future statesmen who might be in possession of more accurate knowledge for their guidance; and that expectation was somewhat tardily justified by the action of Pope Gregory XIII., who in the year 1582 A.D. ordered that October 5 should be treated as the 15th, thus shortening that year ten days to correct the amount by which the years since the Julian Reformation had been too long to keep time exactly with the earth's revolution round the sun. That reformation, then effected wherever the authority of the Pope prevailed, was not effected in England until the year 1752 A.D., by which time the error had increased to eleven days, to remedy which September 3 was reformed by Cæsar; and it therefore shows that after the Julian Reformation three systems were used by Rome—namely, the old style of the era of Rome, the reformed era of Rome, and the Julian era dating from the Julian Reformation. It is immaterial to my argument whether it be based on the eras with their years coinciding, as arranged by the Julian and Gregorian Reformations, or on the old style Roman years, commencing on April 21, and the Julian years of the Christian era, commencing on January 1 allowance being made for the overlapping of the years of the two eras.

ordered to be called the 14th. To prevent a recurrence of the error then corrected it was ordered that three times in each 400 years a year which, under the unreformed Julian Calendar, would be a leap year of 366 days should be a common year of 365 days; but the rigid working of the Julian Calendar in accordance with the Gregorian Reformation still creates an error of one day in about 3,000 years, for the correction of which one of the years which under the Gregorian rule would be a leap year will doubtless be ordered by the authorities of the time to be treated as a common year. The excess in the length of the reformed Julian year, which is now the vulgar or civil year, amounts to about 2 days 14 hours and 24 minutes in 10,000 years. In a paper on 'The Secular Acceleration of the Moon's Motion' which I published in the year 1879 I alluded to the absence of any common measure between days and years as being due to the fact that the motions which they respectively measure are due to the interaction of two independent forces—the sun's and the earth's revolving force—whose relative quantities not only have no necessary mathematical proportion, but have a ratio which is subject to a slowly progressive change which is at present beyond the grasp of mathematical knowledge.

As a matter of detail, it must be observed that between the introduction of the era of the Incarnation into England by St. Augustine and the final restoration of the Julian year, many changes occurred in England. Not only did usage change between the use of the years of the three eras—the Incarnation, the Nativity, and the Julian—but civil and ecclesiastical courts used different

eras at the same time. The change from March 25 to January 1 for the commencement of the year, effected by the Gregorian Reformation, merely corrected the disturbance caused by the temporary adoption of the years specially adapted, sometimes to one and at other times to the other of the two above-mentioned Christian eras, and restored the general use of the Julian year, which does not appear ever to have gone completely out of use.

It must also be observed that the error by which the Christian era has been made to commence with the beginning of the year 1 A.D., instead of treating the first day of that year as the first anniversary of the commencement of the era, is also made in naming the years of the Scaliger cycle, commonly called the Julian Period, of 7980 years (in which the year 4713 of the current cycle corresponds with the year 0 of the astronomical scale), the enumeration of the years in that cycle being made in ordinal numbers because the error seems to have been made in every then existing era except the original Florentine, and when the Scaliger cycle was invented the Florentine figures were erroneously supposed to represent ordinal numbers. The original Florentine system is in fact the present astronomical system of treating the Christian era as above interpreted, and is the only scale of time that has ever been clearly organised on a correct mathematical basis.

The disturbance of the Julian years, sometimes by those of the era of the Incarnation and at other times by those of the era of the Nativity, was due to narrow-minded views of the subject which created confusion

throughout our historical records for more than a thousand years until corrected by our adoption of the Gregorian Reformation.

The Julian year, then legalised, does not appear ever to have been completely out of use. It was used by the kings of England in the eleventh and twelfth centuries; and was afterwards used as the 'historical year' to distinguish it from the year of the Incarnation re-introduced by Henry II; and the documents of the Venetian State Library copied by Rawdon Brown show that in the fifteenth century, more than a hundred years before the Gregorian Reformation, the Popes of Rome were, in the months of January and February, one year in advance of the kings of England in dating their letters, as would be the case if, while the kings of England were using the years of the Incarnation, the Popes of Rome were using the Julian years.¹ Bond, however (in agreement with other chronologers), states that the year of the Nativity was at that time used in Rome, and in that case (which also accords with the recorded letters) then the Popes must have been using the year of the Nativity with the Pisan enumeration while the kings of England were using the years of the Incarnation with the Florentine. Among numerous protests in London of bills of exchange drawn in Venice there is one dated 'on the 31st of December, 1442 (Anglican Style), "secundum cursum et computacionem Ecclesiæ

¹ *Calendar of State Papers and Manuscripts relating to English affairs existing in the Archives and Collections of Venice, and in other Libraries of Northern Italy.* Edited by Rawdon Brown, published by the Lords Commissioners of the Treasury. Vol. i. pp. 134, 135, &c. 1864.

Anglicanæ''':¹ and I see no reasonable explanation for such a specification of the date except on the supposition that the year 1443 A.D. (not 1442) was then the legal enumeration of the year, which had to be distinguished from that legally current in England. That accords with the idea of the English enumeration having originally been cardinal and that used in some parts of Italy ordinal. The general tenour of the admitted historical facts bearing on the question seems to allow of no other explanation for the enumeration of the years of the Nativity (commencing on December 25) having been such as to make them precede that of the years of the Annunciation (commencing on March 25). And the evidence is, therefore, to the effect that the difference of one complete year in the enumeration of the Christian era which at one time existed, as pointed out in 'L'Art de Vérifier les Dates,' was in the first instance reduced to a difference of three months by the years of the Nativity being used with the Pisan enumeration while the years of the Incarnation were used with the Florentine enumeration; that a second approximation was made, reducing the difference seven days further, by changing the Pisan method in Rome from the years of the Nativity to the Julian years; and that the third, and final, step was made by those who used the Florentine enumeration changing from the years of the Incarnation to the Julian years. That seems to me to be clearly the course through which the discrepancy of one year disappeared, and to leave no doubt as to the Pisan

¹ *Calendar of State Papers and Manuscripts, &c.* Vol. ii. p. 568. 1867.

enumeration having originally been ordinal and the Florentine enumeration cardinal.

As a matter of detail it is, however, appropriate to point out that the despatches of the Venetian ambassadors to foreign Courts show that at the time of the Gregorian Reformation (1582) they were using a year commencing on March 1 (not 25), so that in the months of January and February they dated one year less than the date of the Julian year established by the reformation, but all through March their dating corresponded with the established Julian year.¹ They were perhaps also distinguishing their dates from those of the years of the Nativity, but the dates of some of the letters are at variance with the extension of the difference over the intervening seven days. There is a letter from Lorenzo Priuli, Venetian Ambassador in France, which he dates : 'Paris, 11th January 1581 (m.v.),' to distinguish the year from 1582, then presumably current in Rome. But there is another letter of his, preceding the above, dated : 'Paris, 28th December 1581,' as if the year 1582 had commenced in the rival enumeration (not on December 25) but between the dates of the two letters. The evidence is to the effect that the Julian year had been substituted for that of the Nativity before the Gregorian Reformation was decreed, the Bull being dated February 24, 1582, which was then 1581 by the English reckoning.

The relation which I have described between the Pisan and Florentine systems makes it of interest to

¹ *Calendar of State Papers and Manuscripts &c.* Edited by Horatio F. Brown, vol. viii. p. 27, &c. 1894.

notice that Bond, under the heading 'The Era of Pisa,' says: 'This era differed from our common Christian era only by preceding it by one year; probably the first year of the Christian era was made to correspond to 753 A.U.C. instead of 754 A.U.C., the Dionysian date.'¹

The fact certainly is that it was by the Gregorian Reformation that the year 1 of the original 'era of Pisa' was made to correspond with 753 A.U.C., while at the same time the year 1 of *the era of Florence* was made to correspond with 754 A.U.C., as (subject to various changes in both 'eras' between years of the Nativity, years of the Incarnation, and Julian years) the 'era of Pisa' was used in Rome and the era of Florence in England and Venice until the adoption of the Gregorian Reformation in all three places merged the two 'eras' into one. There is certainly no more reason for treating the era of Pisa independently than for dealing in the same manner with the era of Florence. The Pisan appears to have been the original, and to have always been used in Rome; and the Florentine, which became adopted in England and Venice, was merely an attempt to change the Pisan method of enumerating the years without any intention of changing the epoch, or date for the origin of the era. The Florentines, in fact, anticipated the course which has since virtually been adopted by astronomers; but the Pisan and Florentine systems were merely different methods of enumerating the years of *the same era*.

To account for the discrepancy between the vulgar

¹ P. 225, 1875 edition.

Christian era and the true era Bond¹ supposes Dionysius to have been misled through treating the 'era of Augustus' as commencing four years later than its true date; but the object of Dionysius is said to have been to substitute for the era of Diocletian (or the era of martyrs), then chiefly used among Christians, an era dating 'ab Incarnatione D. N. Jesu Christi'²; and, in the absence of any definite proof of his having made the mistake with which he is commonly discredited, it appears to me incredible that he was not fully acquainted, not only with the era of martyrs, but also with the 'era of Christ,' which was then a well-known era also used among Christians; and, if so, he must have discarded what was accepted as the true era, not for the sake of correcting any historical error, but for what he considered the advantage of making it commence with some period in the lunar cycle which regulated the Church festivals, in the organisation of which he was an expert.

Bond treats as the true date of the birth of Christ December 25, 750 A.U.C., which was the first day of the first year in the 'era of Christ'; and Dionysius appears to have substituted March 25 of the year 753 A.U.C. (not 754, as supposed by Bond). March 25, which my argument makes the epoch fixed on by Dionysius, belongs to 753 A.U.C. Julian style; to 752 A.U.C. old style; to 45 of the Julian era; and to 4713 of the Scaliger cycle, commonly called the Julian period. The question, therefore, is as to whether the lunar

¹ P. x of his 1875 edition.

² *Dictionary of Christian Biography*, edited by William Smith and Henry Wace.

TABLE II. GOLDEN NUMBERS OF VARIOUS CYCLES ARRANGED (except overlapping, due to different commencements of the years of each Cycle as shown by Tables III., IV., and V.) as they correspond with the same 'Calendar New Moons.' The figures are extracted from the Table given on page 224 of Bonā's work, which I have quoted on page 14.

Cycle now in use: which appears, by the argument I have given on page 50, to be Meton's original cycle	Meton's Cycle according to Bond	Cycle used in Saxon Charters according to Bond	Dates of Calendar New Moons for the Golden Numbers now in use.											
			Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
I.	XIV.	XVII.	28	31	28	31	31	19	19	17	16	15	14	13
II.	XV.	XVIII.	12	10	12	10	10	8	8	6	5	4	3	2
III.	XVI.	XIX.	1-31	—	1-31	29	27	27	27	25	24	23	22	21
IV.	XVII.	I.	20	18	20	18	18	16	16	14	13	12	11	10
V.	XVIII.	II.	9	7	9	7	7	5	5	3	3	2-31	30	29
VI.	XIX.	III.	28	26	28	26	26	24	24	22	21	20	19	18
VII.	I.	IV.	17	15	17	15	15	13	13	11	10	9	8	7
VIII.	II.	V.	6	4	6	5	4	3	3	1-30	29	28	27	26
IX.	III.	VI.	25	23	25	23	23	21	21	19	18	17	16	15
X.	IV.	VII.	14	12	14	12	12	10	10	8	7	6	5	4
XI.	V.	VIII.	3	2	3	2	1-31	29	29	27	26	25	24	23
XII.	VI.	IX.	22	20	22	20	20	18	18	16	15	14	13	12
XIII.	VII.	X.	11	9	11	9	9	7	7	5	4	3	2	1-31
XIV.	VIII.	XI.	30	28	30	28	28	26	26	24	23	22	21	20
XV.	IX.	XII.	19	17	19	17	17	15	15	13	12	11	10	9
XVI.	X.	XIII.	8	6	8	6	6	4	4	2	1	1-30	29	28
XVII.	XI.	XIV.	27	25	27	25	25	23	23	21	20	19	18	17
XVIII.	XII.	XV.	16	14	16	14	14	12	12	10	9	8	7	6
XIX.	XIII.	XVI.	5	3	5	4	3	2	1-30	28	27	26	25	24

Dates of Calendar New Moons for the Golden Numbers now in use.

According to my argument (on page 50) the dates which now stand against Golden Number IV. belonged to Number I. in Meton's original Cycle for the last six months of the year; and the other six dates are those of the New Moons of the six months preceding Meton's cycle

cycle shows any reason for the selection of *that* date (not for any date in the year 754 A.U.C.).

Bond says: 'To find the number of the Dionysian cycle of 19 years, add I to the given year of the Christian era (because number II belongs to 1 A.D. according to the Dionysian system); then divide the sum by 19, the quotient will show the number of cycles elapsed since the year 1 B.C., and the remainder will represent the year of the cycle.'¹

As the enumeration of the years of the Metonic cycle which was in use at the time of the Dionysian Reformation was then altered for the special purpose of adjusting them to the new era, it seems natural that number 1 should be applied to the first year of the era; and, therefore, the above statement by Bond is a confirmation of my argument to the effect that 1 A.D. represents the second (not the first) year of the era as originally organised. And as the enumeration of the years of the Metonic cycle which had been in use ever since the year 482 B.C. had been changed for use in the Christian Church in such a manner that Number I of the cycle corresponded with the year 1 of the 'era of Christ,' the question is as to whether the organisation of the calendar shows any reason for combining with a change from the years of the Nativity to those of the Annunciation a change of three years in the 'golden numbers' of the lunar cycle as then used in all Christian Churches. The facts of the case appear to me to make it evident that for the commencement of the year the date of the Annunciation was preferred to that of the Nativity on account of the dates of the

¹ P. 253, 1875 edition.

Church festivals being determined by the new moon of the vernal equinox ; and that the year 753 A.U.C., Julian style, was preferred to any other in the same lunar cycle because the calendar new moon next preceding that equinox occurs closer to the equinox than in any other year of the cycle. That appears to afford a still further confirmation of my argument to the effect that Dionysius considered what is now 1 A.D. to be the 2nd year of the era. The calendar shows no reason for taking any year marked by the golden number II as the first year of the era.

The Dionysian Reformation not only abandoned the then existing era of Christ commencing on December 25, 750 A.U.C., but also abandoned the numbering of the Metonic cycle based on that era, and applied number I of the cycle to what is now erroneously called 1 B.C. instead of to 4 B.C., as then numbered for the original 'era of Christ,' which commenced on Christmas Day of the year 4 B.C. of our vulgar era.

As the original numbering of the Metonic cycle as arranged in 432 B.C. had in fact been changed in such a manner that Number I corresponded with the year 1 of the era of Christ, Dionysius and those who acted with him must have had a thorough practical knowledge of it, and cannot have been influenced by any historical mistake in the matter.

It is important to observe that the golden number I of the Metonic cycle which Dionysius discarded did not agree with the year 1 of the era of martyrs, but with the year 1 of the era of Christ, so that if he had merely wished to change from the era of martyrs to

the era of Christ all that was requisite was to change the enumeration of the years of the era by adding 287 years so as to make the era commence in the year of the golden number I as then applied to the Metonic cycle used with the era of Christ; and he would then have had for the epoch of the era what he must have well known to be a closer approximation to the true date of the birth of Christ than that which he adopted. That is so because, as the year 288 of the era of Christ commenced in the year 1 of the era of martyrs, the addition of 287 years to the latter era would have made the enumeration of years of the era of martyrs and the Golden Number I of the era of Christ coincide at the epoch of the latter era, which became known as the *annus verus* in contradistinction to the *vulgar epoch*.¹

¹ Bond (p. x, 1875) says: 'The first year of the *first* Dionysian Pascal Cycle of 532 years' was '1 Anno Domini with golden number II of the Dionysian Cycle.'

That statement, however, tends to create confusion in three distinct ways.

First, because it is only by applying the Gregorian reform to our golden numbers and not to the Pascal Cycle that golden number I and year 1 of the Pascal Cycle are made to differ at all. They certainly coincided when Dionysius framed the cycle and adopted the golden numbers.

Secondly, because it is only the last three months (less seven days) of the year 1 of the Pascal Cycle to which golden number II can in any sense be applied.

And, thirdly, because the enumeration of the years of the first Dionysian Pascal Cycle of 532 years is in fact the original Dionysian enumeration of the years of our era, being identical with the era of Pisa, which, as I have already shown, was used in Rome, while the era of Florence was used in England.

I do not point out the above for the sake of being hypercritical regarding statements which suited Bond's immediate purpose in verifying dates,

It must also be observed that a full moon more closely precedes December 25 in the golden number I of the Metonic cycle which agreed with the year 1 in the era of Christ than in any other year of the cycle, whereas August 29, which was the epoch in the era of martyrs, has no definite connection with the lunar cycle. The evidence is, therefore, to the effect that the true era of Christ (as well as the era of martyrs) was deliberately rejected in the Dionysian Reformation for the sake of adopting the first epoch in the life of Christ which best suited as a basis for the regulation of Church festivals as then organised. And it seems also probable that the epoch Christmas Day of the 'true era of Christ' was determined as much by the dates of calendar full moons¹ in the Metonic cycle as by any accurate knowledge of the true date of the birth of Christ. It can only be said to be more nearly true than the date according with the Dionysian epoch.

A peculiarity of the calendar which I have not seen anywhere mentioned, is that the approximate dates of the new moons have long been, and will for many years continue to be, two years in advance of the golden number to which the present dates were adjusted in the Dionysian cycle. That is to say, the year 1900 is quite correctly designated in the almanac

but in order to clear apparent clashing between some of his statements and my arguments.

¹ Playfair, in his table of eclipses in the work I have already quoted on p. 28, records an eclipse of the moon as having occurred on March 13, 4 B.C., and full moon would therefore occur on December 3 of that year and again on January 2, 3 B.C.; so that the calendar full moon of the epoch Christmas Day of the original era of Christ appears to have occurred about eight days before the real full moon.

as being golden number I. of the cycle ; but the new moons are not those which belong to number I., but are those which belong to number III. For seven of the moons the calendar date is the same as that of the almanac ; and for the other five moons the greatest discrepancy is less than twelve hours, which is a discrepancy which must of necessity arise in the calendar in consequence of the lunations being reckoned sometimes as twenty-nine and sometimes thirty days instead of in accordance with the actual change in the moon's position. The table which I have given on page 40 can easily be compared with the almanac for many years to come for verification of the position of the real moon in relation to that of the calendar. That table gives the dates of calendar new moons in the line of the golden number for the year, and the dates of real new moons for the same year are those of the calendar new moons two years in advance.

For about twelve moons following any 29th day of February, the almanac date will usually be one or two days less than the present amount of eight days in advance of the calendar ; and then the discrepancy will again gradually increase until another leap year stops the moon's advance in the almanac by pushing the enumeration of days forward to keep pace with the moon. The mean advance between two successive leap years does not make the almanac correctly measure astronomical time, because an allowance for further correction must be made at the rate of 2d. 14h. 24m. in 10,000 years (see p. 33). The mean difference between our almanac measure and astronomical measure since 0 A.D. now amounts to twelve hours ; and that difference will go on

increasing until one of the years which the calendar as now arranged makes a leap year is treated as a common year. By skipping a leap year now the discrepancy between true measure and almanac measure since the epoch of our era would not be corrected, but approximately reversed. The almanac was adjusted to the moon in 1582 A.D., but the above correction is required in both directions from that date. It ought not, however, to be made until the discrepancy exceeds half a day in relation to that adjustment.

The reason for the existing position of the moon in relation to the calendar is that it loses 2 hours 5 minutes, about, in each cycle, making rather more than 8 days in the 1900 years;¹ and that difference chances to bring it into agreement with the calendar moons of golden number III. The fact that the discrepancy of 8 days is the actual difference between years I. and III. of the cycle appears to make the calendar in the first year of the era agree with the moon; but a closer inspection shows 8 days to be the maximum and 5 days

¹ Playfair (on page 16) makes :

$$\begin{array}{r} 19 \text{ years} = 6939\text{d. } 14\text{h. } 26\text{m. } 24\frac{1}{2}\text{s.}, \text{ and} \\ 235 \text{ months} = 6939 \quad 16 \quad 31 \quad 0 \end{array}$$

$$\begin{array}{r} \text{difference} \quad \quad \quad 0 \quad 2 \quad 4 \quad 35\frac{1}{2} \end{array}$$

And the relative lengths of the year and the astronomical month now accepted make the figures :

19 years of 365d. 5h. 48m. 46s. and 235 months of 29-53059 days equal respectively :

$$\begin{array}{r} 6939\text{d. } 14\text{h. } 26\text{m. } 34\text{s.}, \text{ and} \\ 6939 \quad 16 \quad 31 \quad 31\frac{1}{2} \end{array}$$

difference $0 \quad 2 \quad 4 \quad 56\frac{1}{2}$; and the secular acceleration of the moon makes 2h. 5m. a closer approximation; making the difference in 1900 years = 8d. 16h. 20m., or about $8\frac{2}{3}$ days.

the minimum advance of our almanac dates on those of the calendar of Table II. The average advance on the dates as they stand in that table is only 6 days 17 hours, which does not agree with the idea of its having been adjusted to the moon, either at the commencement of the Christian era or at the time it was brought into use. The moon of the Church calendar appears to have become quite independent of the real moon before Dionysius reorganised the calendar, and he evidently did not base his reform on what was then the true position of the moon.

The evidence is to the effect that the positions of the calendar moons as they stand in Table II. in relation to the golden numbers now in use were adjusted to the moon about three centuries after the commencement of the Christian era; and that Dionysius, therefore, must have brought back into use an old calendar without attempting to make it conform with the changed position of the real moon in relation to it.

To make the basis of argument quite clear, I may point out that Sir Harris Nicolas extracts from 'L'Art de Vérifier les Dates' a 'Perpetual Lunar Calendar' in which the moons placed against the golden numbers now in use accord with what I have given on page 40, but he says: 'To the golden number which was used for ascertaining when the new moons occurred for the *old* style, epacts have succeeded for the *new*.' The dates given in that calendar are, however, the Dionysian calendar moons *of those respective golden numbers* in the new style; and the discrepancy I deal with is the same whether the argument be based on the dates of the new or the old style almanac, correctly extended

back to Meton's time, or on the almanac dates of Meton's time correctly extended forwards to our time. My argument deals only with the dates indicated by the 'Perpetual Lunar Calendar' based on the golden numbers of the Metonic cycle and the *natural* discrepancies between those calendar moons and the real moon. I am not concerned with the *artificial* arrangements for corrections organised either in the Dionysian or in the Gregorian calendar. At the time of the Gregorian Reformation the date of the moon indicated by the golden number was about seven days *before* that of the real moon, but the corrections in the calendar as it had been organised had actually made the calendar moon five days *later* than the real moon. The extreme discrepancy that can arise under the new style is, according to Nicolas,¹ three days; and De Morgan considers part of that discrepancy to have been purposely organised in order to keep Easter Day from coinciding with the Passover.²

Another peculiarity which I have not seen alluded to appears only when it is recognised that before Dionysius changed the positions of the golden numbers

¹ *The Chronology of History*, by Sir Harris Nicolas, K.C.M.G., p. 80. 1833 (London: Longmans).

² 'On the Ecclesiastical Calendar,' pp. 18, 19, &c., *The British Almanac*, 1845. De Morgan gives the following quotation from Clavius, who organised the new calendar: 'If the moon of the cycle fell on the same day as the mean new moon of the astronomers, it might chance that we should celebrate Easter on the same day as the Jews or the Quartodeciman heretics, which would be absurd, or else before them, which would be still more absurd.' Clavius seems to me to have been in advance of the calendar in referring to the time the Jews 'celebrate Easter'; but the extract makes it clear that a discrepancy between the calendar and the moon was purposely created. The calendar of the Metonic cycle is independent of any such arrangement of the ecclesiastical calendar.

in the Metonic cycle they stood as they had been arranged to suit the era of Christ. And the point is that, as that era commenced three years before the era Dionysius was substituting for it, he would of *necessity*, on deciding to change the golden numbers, have made his number I take the place of number IV of the era of Christ, if the calendar moon then agreed with the real moon and if he wished it to continue to do so. If he had made that change, he would simply have reverted to the original numbering of the Metonic cycle.¹ But, instead of moving his numbers three years *forward*, he moved them three years *back*, making his number I take the place of number XVII;² so that the golden numbers of the existing era must be considered to commence either three years *before* or else sixteen years after those of the era of Christ, though the era itself undoubtedly began three years *after* the era of Christ. That seems to confirm the view I have already expressed to the effect that he selected for the golden number of his epoch year the March new moon of *the calendar*, which best suited as a starting point for the era; and it makes him appear to have cared as little for the relative positions of the new and the old golden numbers as for the relative phases of the real moon and those of the moon of the calendar.

A third peculiarity which I have not seen alluded to, and which seems worthy of special attention as throwing

¹ That which (as shown in Table II.) Bond treats as the original cycle, but which appears to me to have been framed more recently.

² Supposing the relative positions of the numbers in Bond's table to be correct; but I have (in connection with Table V.) shown that Meton's number XVII, to which number I of the era of Christ was applied, is that *now in use*.

a new light through the confusion, is that Bond gives July 13, 432 B.C. as the epoch of Meton's cycle without specifying any authority for that date (which has in fact become generally accepted); whereas Playfair gives July 16, 433 B.C. and states that a new moon which occurred at 7.43 P.M. on that day fixed Meton's epoch.

The point is that, if Playfair is right as regards the day of the month, then the new moons of golden number I in Meton's original calendar have been made to correspond with golden number I of the cycle which Bond gives as that of the Saxon Charters, but the golden numbers themselves as we now use them stand just as originally arranged by Meton, forming the only unbroken record of years which has existed from so early a date in Europe; and his cycle must have commenced in 437 B.C. (astronomical=vulgar 438 B.C.), which is 23 cycles before the year 0 (vulgar 1 B.C.).

The evidence in support of the above view is as follows:

According to both Playfair and Bond, the 123rd of the Metonic cycles is now current and not far from ended; and in that time the moon must have advanced in relation to the calendar moon rather more than $10\frac{1}{2}$ days ($122 \times 2^h 5^m = 10^d 14^h 10^m$ and $123 \times 2^h 5^m = 10^d 16^h 15^m$).

That makes Playfair's new moon of July 16 correspond with the new moon of July 26, 1881, as ending the 122nd cycle, and the new moon of July 26, 1900, as ending the 123rd cycle. And, as 123 cycles are 2337 years, Playfair's new moon of July 16 must have been July 16, 437 B.C. astronomical, which is

438 B.C. of vulgar reckoning (not 433, as recorded by him).¹

¹ An exact verification of the advance of the moon from the almanac dates of Meton's time cannot be made without having the *hour*, as well as the *day*, of each new moon of his calendar. For an approximation, the days of new moons in his calendar must be set against the days of the corresponding moons in our almanac, disregarding the additional hours of each moon. Tested in that manner, the average advance of the dates of the moons in our almanac from the corresponding dates of the calendar in Table III. is 9 days 20 hours, instead of 10 days 16 hours, making an apparent discrepancy of 20 hours. The greater part of that discrepancy is, however, accounted for by $13\frac{1}{2}$ hours included in the 2 days 14 hours 24 minutes which the calendar gains in 10,000 years, as explained on page 33 (10,000 years : 2 days 14 hours 24 minutes :: 2,337 years : $13\frac{1}{2}$ hours). And that the remaining difference ($6\frac{1}{2}$ hours) is due to the allowance of leap years having given a correction in excess of what had been immediately requisite when the last February 29 had been inserted, is shown by the fact that the omission of February 29 in the year 1900 has made the average amount by which the moons from July 1900 to December 1904 are in advance of Meton's calendar 10 days 21 hours, thus approximately reversing the discrepancy.

Another test is obtained by deducting Meton's epoch from the conclusion of his 123rd cycle, as follows :

437 B.C. July 16	7h. 43m. P.M.
from 1900 A.D. July 26	1 43
difference 2337 years	9 18 0
2h. 5m. \times 123 cycles =	10 16 15
difference	0 22 15

By making the year 1900 a leap year, the date of the above new moon would have been July 25, 1h. 43m. P.M., making the difference 1d. 22h. 15m. ; so that the omission of February 29 in the year 1900 appears by this test also to leave more than half a day accumulated towards another omission not yet fixed in the almanac.

As a basis for the discussion of this subject it is necessary to recognise that though, by a discrepancy in one direction chancing to counterbalance another discrepancy due to some other cause, the almanac might possibly coincide with the moon at different dates, and show the same period for separate lunations, the existence of secular acceleration makes it impossible for such a coincidence to be effected by a recurrence of the same causes in any cycle.

As William Smith, after saying that 'the acknowledged epoch of commencement of the period has been placed B.C. 432,' further says, 'but we are far from seeing how it has been made out,'¹ it seems to me that the argument I have given probably establishes the true epoch.

That makes it appear that Dionysius must have found Meton's original cycle with the calendar moons readjusted to an early period of the Christian era, and brought it back into use as he found it; and also that the cycle which Bond gives as Meton's must have been framed for some subsequent purpose.

It is easy to be misled in the confusion which has been created in connection with the calendar; but it appears nevertheless not out of place, in connection

If there were stability of action in the forces by which the solar system is controlled, then (except slight differences in the effects of perturbations by the planets) there would be equal intervals of time between each recurrence of a new moon at (1) the same distance from the earth, (2) the same distance from the sun, (3) the same distance from the plane of the earth's equator, (4) the same distance from the plane of the sun's equator, and (5) with the earth in the same position in relation to the sun and moon; but a changing ratio of forces prevents a recurrence of all those conditions in combination, as certainly as the course of evolution prevents any man from being twenty-one years old twice in his life. A verification, subject to a small discrepancy which would represent the secular acceleration combined with a slight difference in planetary action in each cycle, which latter is on the average a retarding action, but greater in some cycles than in others, could be arrived at by calculating the position of Meton's epoch new moon in all the five above specified respects, to make the requisite allowance for divergence of the new moon of July 26, 1900, from each position. That elaborate analysis is not, however, I think, required for my purpose, as the rough approximations I have given appear sufficient to establish my argument.

¹ *Dictionary of Greek and Roman Biography*, edited by William Smith, vol. ii. p. 1069. (John Murray, 1846.)

with my argument, to give the foregoing indication regarding Meton's epoch *quantum valeat*.

If the cycle of golden numbers now in use really is, as I have suggested, Meton's original cycle, the question arises as to what is the origin of that which Bond has considered to be Meton's original cycle. That cycle seems to me to have been framed after the commencement of our era with the year of the Crucifixion for its epoch.

The evidence bearing on that point is the fact that in the year 1896 the moon had gained eight days on the calendar which Bond treats as being the one originally created by Meton in 432 B.C. ; and, therefore, instead of corresponding with the calendar in Meton's time, it conformed with it at or after, rather than before, the Christian epoch ; so that it is probably a reorganisation of Meton's calendar created for some era brought into use about that date. And as the golden number I of that calendar corresponds with 33 A.D., which is the generally accepted date of the Crucifixion, the two coincidences justify its being regarded as the cycle which was used with the 'Era of the Crucifixion' in the absence of definite evidence to the contrary.¹ All

¹ Taking the full moon which occurred between the new moons of March 6 and April 5, 33 A.D., as the epoch of the era, the average advance of the moons of the first five years of the calendar given in Table IV. is 8 days 6 hours ; which, with 12 hours accumulated towards the *correction of the almanac* independently of the organised leap years (as explained on page 33), makes the average advance shown by those five years 8 days 18 hours ; which shows the calendar to have been correctly adjusted to the moon in 33 A.D. The evidence is to the effect that golden number I was applied to the calendar moons of March 6 and April 5, because those were the dates of the real new moons at the time of the Crucifixion ; and subsequent arrangements have chanced to make 33 A.D. correspond with them.

that concerns my argument, however, is that it certainly is not Meton's original cycle. The evidence based on that calendar is that the full moon of the Crucifixion occurred between real new moons of March 6 and April 5; and also that golden number I was therefore applied to those moons, and was, together with them, given the position properly belonging to Meton's golden number XV, which is the number belonging to 33 A.D. in both those months. The moons of Meton's number XV are March 5 and April 4, and had advanced a full day when the Era of the Crucifixion was framed.¹ Table IV. serves to elucidate that point. The invalidation of the claim of that cycle to be considered Meton's is a further argument for consideration of that which I have given in Table III.

It appears to be mere matter of fact (be the explanation what it may) that the calendar moons of the cycle now in use were moved to their present positions 4 golden numbers in advance of those against which

¹ In Table IV. I have altered the relative positions given by Bond to the golden numbers of the two cycles, but in doing so I keep in accord with an argument alluded to by him to the effect that the Crucifixion occurred in a year of Meton's cycle number XV (see p. 233 of his 1875 edition), together with my argument to the effect that he has mistaken the golden numbers of the Era of the Crucifixion (instead of our present numbers) for Meton's original numbers.

It therefore appears that the generally accepted date of the Crucifixion, and my argument regarding the relation of those calendars, mutually confirm each other; whereas Bond's argument leads him to make the date of the Crucifixion 30 A.D.; and his divergence from the accepted opinion seems to be explained by the facts that his arguments are based to some extent on what he supposes to be Meton's cycle, but which he treats as commencing its golden number I in what is really Meton's number IV; so that the true date is three years in advance of that supposed by Bond.

they stood in the calendar used with the era of Christ, and that the change brought them approximately into accordance with the real moon, not at the time of the Dionysian Reformation, nor at the epoch of the Christian era, but at that of the era of Diocletian, 284 A.D. ; so that as Dionysius, while discarding the era of Christ, discarded also the calendar framed for that era, he may probably, while also discarding the era of martyrs, have either kept in use, or else brought back into use, the calendar which had been specially framed for that era ; for the era of martyrs was merely the name applied by Christians to the era of Diocletian, which was for a long time the prevalent and official era in Rome.¹

And it also appears to be mere matter of fact that the calendar used with the era of Christ, which

¹ The era of martyrs is referred to by some writers as if it were a Christian era established to commemorate the multitude who were cruelly slaughtered in the reign of Diocletian, and Bond says nothing in definite refutation of that erroneous idea. In his Preface he says 'the early Christians adopted an era which they called the Era of Martyrs.' And when stating that the era is 'also called the Era of Diocletian,' he says it dates from the reign of Diocletian 'in consequence of the persecutions of the Christians by that emperor.' The fact is that the era was not in any sense a consequence of those persecutions ; and when it was established in 284 A.D. Diocletian was quite the reverse of a persecutor. The cruelties which led the early Christians to abhor the use of his name occurred in 303 A.D., and are considered by Gibbon to have been the cause of Diocletian's abdication. The action of Pope Hilarius in substituting the era of Christ for the era of martyrs seems to have been influenced by the same feeling as that which had led Christians to substitute the term Era of Martyrs for Era of Diocletian.

In establishing an era dating from his own reign, Diocletian followed the example set by Cæsar ; but if Cæsar had been satisfied with reforming the era of Rome without introducing a new era, it seems unlikely that any emperor could have ventured to displace it, and the reason which led the Christian world to do so would not have existed.

Dionysius discarded, is Meton's original calendar moved bodily—that is to say, the golden numbers moved together with their corresponding moons—three years back from their original position in time; that is to say, from the positions in which the calendar moons and the respective golden numbers would have stood if Meton's calendar had been undisturbed. That is made clear by comparison of Tables III and V.¹

The cycle of golden numbers which Bond gives as those used in Saxon Charters, and as having been introduced in 463 A.D., must therefore, if that is the true date of its origin, have been expressly arranged by Pope Hilarius to suit the era of Christ; and his re-organisation consisted merely of a change in the position of Meton's calendar by pushing it back so

¹ The golden numbers may have been continued to be applied to *all* the same calendar moons as in Meton's calendar; but I have made number I in Table V. begin with the December new moon preceding the full moon of the first Christmas Day, because the coincidence of Meton's original number I with the full moon of the first Christmas Day is all that concerns my argument. The new moon of December 23, 1897, completed 100 cycles from the epoch of the era of Christ, showing an advance of 13 days on the calendar moon of December 10; which makes it evident that there was never any pretence of adjusting the moons of that calendar with the real moon. That calendar accords with the moon nearly 1,000 years before *Meton's* time.

I take it for granted that Bond has given correctly the calendar moons for the respective cycles; and the evidence I have adduced seems to me to justify the change I have made in the relative positions of the golden numbers themselves. I have (on page 48) commented on the peculiarity of the relative positions of the numbers in Bond's table; and the admitted fact that the era of Christ began three years *before* our era fixes its epoch to our golden number XVII, so that if golden number I was applied to the epoch of the era of Christ—it must of necessity correspond with our number XVII. And, also, as Bond makes the era of Christ begin with what *he* calls *Meton's* number XVII, the question is as to which of the two cycles really is Meton's.

as to make the full moon which occurs on Christmas Day in his calendar coincide with December 25, 750 A.U.C., which he had fixed on as the epoch for the commencement of the era of Christ, though the change did not bring the calendar moon into conformity with the real moon. That calendar must have been created in that manner whether it originated at the time of Pope Hilarius or at any other time. Neither Playfair nor the author of 'L'Art de Vérifier les Dates' appears to have had knowledge of the calendar of the era of Christ; but it seems probable that evidence may be found of it having been used in many parts of Europe before the era of the Incarnation was invented by Dionysius. If it is the calendar used in Saxon Charters in England, it must have been brought into this country before the time of St. Augustine, as he would not have introduced it after the Christian era organised by Dionysius had been adopted in Rome. In the printed list of old documents in the British Museum there is not, however, anything in confirmation of this suggestion.

There probably exist in some old libraries records regarding the relative ages of these calendars. The evidence I find available is to the effect that the calendar which Bond gives as Meton's was in fact created *after* the epoch of the Christian era. That evidence is given by the position of the moon of that calendar in relation to the real moon, and by the coincidence of its golden number I with the accepted date of the Crucifixion. And the evidence as regards the calendar used with the era of Christ is that it was created by Pope Hilarius to be used in substitution of that specially

created for the era of Diocletian; but the calendar itself gives no clue as to the date of its creation. Its golden number I is, however, so displaced from its position in Meton's calendar as to show that, whatever may have been the date of its origin, it was created specially for the era of the Nativity. Whatever may have been the case as regards the calendar of the era of the Crucifixion, it is evident that the calendar of the era of Christ must at one time have been used in Rome in substitution of that of the era of Diocletian; and, in the absence of evidence of the latter having been reverted to before the time of Dionysius, it appears that he discarded not only the *era* of Christ, but also the calendar which had been framed for it, and re-adopted the calendar of Diocletian for use with the vulgar Christian era. It is quite possible, or indeed most probable, that Dionysius and those acting with him were influenced by the fact that the course they were taking replaced Meton's golden numbers in their true positions, making them a correct record of years from Meton's epoch; at any rate, it appears that they effected that useful reform, whether by deliberation or accident.

If Dionysius did not knowingly revert to Meton's cycle when discarding that of the era of Christ, as I have suggested, the alternative explanation is that the calendar of Diocletian, which must have been then well known, had been framed on Meton's original cycle with the calendar moons adjusted to the true moon at the Diocletian epoch without disturbing the golden numbers, and as Dionysius did not adjust the calendar to the moon in 532 A.D., the probability

seems to be that he merely re-adopted the use of the calendar of Diocletian as it stood.

De Morgan says : ' Dionysius Exiguus seems to have done no more than accommodate the cycle of Victorinus to his new mode of reckoning ; he being the person who first abandoned the era of Diocletian, and reckoned from the supposed year of the birth of Christ.'¹

As ' the cycle of Victorinus ' is that of Pope Hilarius, De Morgan's statement confirms the view I have given as to the era of Christ having been substituted in Rome for that of Diocletian ; but the tables I have appended and the arguments referred to in them show that, if that was so, Dionysius deliberately abandoned the cycle and calendar moons framed for the era of Christ together with the era.

The acceptance of the argument to the effect that the golden numbers as now used stand as placed in Meton's original cycle vitiates arguments Bond has based on the supposition of Meton's cycle having been that which appears to me to have been created for the era of the Crucifixion ;² but I cannot point that out without expressing an opinion to the effect that Bond's work is the most valuable contribution to chronology since the publication of ' *L'Art de Vérifier les Dates.*'

¹ Article, ' On the Ecclesiastical Calendar,' p. 9, by A. De Morgan, *The British Almanac*, 1845.

² Bond does not state his authority for what he supposes to be Meton's cycle. But he seems to have accepted its identity as an established fact, and to have based arguments confidently upon it without any thought of questioning the historical accuracy of that supposed origin. It seems to me that he is certainly mistaken where (on page xxxii of his Preface) he supposes it to be the one which was in use by the Jews in the time of Christ.

De Morgan's interesting contributions¹ do not pretend to a position of such practical utility; and he appears to have misappreciated the importance of a correct record of time, as he alludes to the Gregorian Reformation as 'the stupid expedient of destroying ten nominal days, which has created more confusion and more chronological error than all the anomalies of the old calendars put together. . . . The Gregorian Reformation has done much in this way; another attempt would go near to render the chronology of the country in which it was made an unfathomable mystery.'² Most practical men will, I think, agree that the mischief was created by those who failed throughout the 'Dark Ages' to act on the principles on which the Julian Reformation had been based, and that the Gregorian Reformation merely grappled with that mischief and prevented the years from ceasing more and more to constitute a true record of time. The plea of *factum valet* superimposed upon *feri non debuit* is too often urged against the revision of such mistakes as that for which the Gregorian Reformation contrived a practical correction; and any confusion now connected with it may be considered as of a trifling character in comparison with that of the confusion which it averted.

A more practical view of the question is expressed by Sir Harris Nicolas, who says: 'The absurdity of retaining the 25th of March as the beginning of the year, not because it was the 25th of March, but because it was the time of the vernal equinox, which, in the

¹ *The British Almanac*, 1845, 1846.

² *Ibid.* 'On the Ecclesiastical Calendar,' pp. 12-36.

eighteenth century, had receded so far back as from the 25th to about the 10th of March, was forcibly urged by Wilson in 1735. . . . These anomalies, nevertheless, continued for seventeen years longer; and the reformation of the calendar, when it did take place, was offensive in the highest degree to a large part of the kingdom.¹

De Morgan alludes to the illness and death of the Astronomer Royal, James Bradley, having been 'attributed to a judgment from Heaven,' as if he intended the animosity aroused against Bradley to serve as a warning to all men in positions of authority to leave established errors uncorrected;² but, I think, most men will now consider Bradley's action in the matter to have been more worthy of his position in the scientific world than De Morgan's policy of inaction.

The confusion has been a necessary consequence of applying Meton's cycle to a purpose for which it is not suitable. To get a really perpetual calendar the ecclesiastical authorities ought to have used *thirty* 'golden numbers' instead of *nineteen*; making the number of the first day on which a new moon occurred in any year the golden number for that year.

Under such an arrangement the moon could never escape more than a fraction of a day from the calendar moon, and the latter would automatically readjust itself to the moon instead of allowing the discrepancy to accumulate as it does in Meton's cycle.

The above arrangement would not have suited

¹ *The Chronology of History*, by Sir Harris Nicolas, K.C.M.G., 1833 (London: Longman, Rees, Orme, Brown, Green, & Longman).

² 'On the Ecclesiastical Calendar,' p. 131.

Meton, because he required numbers to use in arithmetical sequence; but it appears to me that for the purposes of the calendar the sequence of the golden numbers is as immaterial as that of the Dominical Letters.

*Si quid novisti rectius istis,
Candidus imperti; si non, his utere mecum.*

As the Roman era prevailed in Europe at the time of the introduction of our present era, it is of interest to record that it is now certain that the year 1 of Rome does not correctly represent the year of the foundation of that city, regarding which there are wide discrepancies of opinion, whereas as regards the year 1 of Nabonassar the only doubt is as to whether it represents the year of the foundation of the Second Babylonian Empire or the second year of that empire. It is a point of interest, because the year of Rome, framed by Julius Cæsar, and the year of Nabonassar, framed by that king at the commencement of the Second Babylonian Empire, are the two antecedent phases through which our present system has been evolved from a chaos of lunar, luni-solar, and solar measures of time, which appears to have been sometimes made to run fast by counting lunations as years.

The solar year seems to have been undoubtedly invented in Egypt, whether by Edomite invaders, Jewish conquerors of the latter, or by native Egyptians. It was never officially adopted by the Jews, but became important in chronology through its adoption by Nabonassar in Babylon in displacement of the year of twelve lunations, with occasional intercalary months

as still used by the Chinese; and it became firmly established in Europe by the Julian and Gregorian Reformatations. It is well to recognise that the Gregorian Reformation was necessitated only because up to the time of Gregory XIII. the successors of Julius Cæsar failed to act on the principles on which the Julian Reformation was based.

The immediate origin of the solar year as the unit of measure in the scale of time is narrated by Sir Isaac Newton, who says¹ that King David's conquest of the Edomites gave him possession of ports on the Red Sea, and at the same time the Edomites, driven by him into Egypt, became the first inventors of the use of sailing ships by availing of the art of making linen cloth already known in Egypt, and thus created an extension of commercial enterprise which 'gave a beginning to astronomy and navigation.' The navigators were obliged to observe the positions of the stars to enable them to know their course when out of sight of land, and were thus led to the invention of the solar year of 365 days, which, 300 years after David's extension of his kingdom to the Red Sea, was adopted in Babylon as the year of Nabonassar. The merits of that system were doubtless well known in Jerusalem long before they became known in Babylon, though the vast importance attached to ritual in the religious ceremonies of the Jews made the official recognition of the system in use among the Jewish traders impossible in their own country. The rapid development of trade and commerce which followed the appearance of the Jews on the Red Sea as a powerful nation rendered the reign of

¹ Horsley's edition of Newton's Works, vol. v. pp. 135 &c.

King Solomon one of the most important epochs in the world's history ; and the astronomy of Egypt was carried to Babylon by the extension of ocean commerce inaugurated by the Jews through the Red Sea and the Persian Gulf. The extension of trade and commerce which was inaugurated by King David may well be regarded as of not less epoch-making importance in the history of the world than that which followed the discovery of the western hemisphere in the reign of Ferdinand and Isabella.

In his chapter on the 'Chronology of the Greeks,' Sir Isaac Newton makes some remarks which may well be recapitulated for the purpose of eliminating sectarian spirit from the merits of the question as to the improvement of the existing system of chronology.

Newton concludes that chapter by saying that 'the morality and religion of the first ages still called by the Jews "The precepts of the sons of Noah" is the primitive religion of both Jews and Christians, and ought to be the standing religion of all nations, it being for the honour of God and good of mankind. . . . The believing that the world was framed by one supreme God, and is governed by him ; and the loving and worshipping him, and honouring our parents, and loving our neighbour as ourselves ; and being merciful even to brute beasts, is the oldest of all religions.'

Those words of Sir Isaac Newton seem appropriate and worthy of consideration in connection with any attempt to strengthen the foundations of the Christian era.

What is, however, immediately practical in the subject is the fact that there has never existed any

system of chronology which, whether considered on its theoretical merits or as regards its extensive practical use in scientific records, can be placed in rivalry with the present astronomical system; and the arguments I have adduced show, I think, its point of variance as regards our vulgar system to be due to an error in the latter which admits of easy reformation so as to identify vulgar with astronomical reckoning.

The most important reform ever effected in chronology is that by which the practical system invented by the necessities of commerce was officially substituted in the Babylonian Empire for what had previously been their vulgar system; and a further development is now called for to bring the system practically forced on astronomical science officially into our vulgar chronology.

Many eras have been used for chronological records, and until one has been established on a correct basis rival eras will doubtless continue to compete in the struggle, in which the fittest will survive.

The tangled confusion of records, even since the establishment of the Christian era, leads Mr. Arbuthnot, to whose work I have above referred, to propose that we should inaugurate a new era dating from the commencement of the reign of Queen Victoria; but such a course would, like the similar action of the first French Republic, make confusion worse confounded without any compensating advantage to be gained by attempting, like the first French republicans, to displace an era which has become accepted wherever European civilisation has established itself. The more natural and expedient course appears rather to be to disentangle

as far as possible those records and establish their true positions in the existing era.

In 'Macmillan's Magazine' for February 1900 a writer under the initials A. G. comments on the confused position of the subject in the words :

On algebraic tokens weird,
On decimals I daily pore ;
By these my mind is nowise cleared ;
They leave me where I was before.
By decimals correctly done
Can Speculation e'er be taught
To learn if time begins at *one*
Or *naught* ?

The discussions of to-day in the Battle of the Centuries have the same *raison d'être* as those which must have been rife more than a thousand years ago in the battle between the ordinal and cardinal enumeration of the years of what was then the newly invented era. But the present position has been further complicated by what I trust I have clearly shown to have been a mistaken numbering of the B.C. years.

But for that mistake the Florentine enumeration, after it had displaced the Pisan, must have continued to be treated as cardinal, and astronomers would have had no reason for inventing a special system for their own use, as their system is in fact an independent re-invention of the original Florentine system.

If 1 B.C. is to be allowed to continue to immediately precede 1 A.D., as it does in our existing vulgar system, the twentieth century cannot commence until 1900 A.D. has ended; and the German Emperor's celebration of the commencement of the twentieth century on January 1 of this year (1900) therefore virtually constitutes a

step toward bringing vulgar reckoning into accordance with that of astronomers. That celebration also accords with the words of the English Prayer Book which declare the nineteenth century to be 'from the year 1800 till the year 1899 inclusive.'

The Prayer Book and the German Emperor are, however, virtually in accordance with the astronomical system, and their position in the question cannot logically be maintained without a reformation as regards the vulgar numbering of the B.C. years.

What is wanted now to give practical effect to the reform which has been virtually decreed by the German Emperor is that some leading historical society should compile and publish a Chronological Table conforming with the astronomical method of numbering the years in both directions from the present zero year of astronomers; and that the above statement promulgated when the English Prayer Book was first published should be officially re-affirmed; for the position, according to the foregoing argument, is such as to make it as imperative on all nations who use the era to clear away the error which has crept into it, as it was for all who aspire to the front rank in civilisation to adopt the Gregorian Reformation.

TABLE III. METON'S ORIGINAL CALENDAR.

Public knowledge of the identity of this Calendar appears to have been lost in the Dark Ages, and it is now for the first time, as far as I know, printed. Its correctness is dependent on Playfair's statement, which I have quoted on page 50. The epoch of the Calendar being the New Moon which occurred on July 16, 437 B.C. Astronomical (438 B.C. Vulgar), its 123rd Cycle ended and 124th commenced with the New Moon of July 26, 1900 A.D., being 2337 years and 10 days from its epoch, the date of New Moon having advanced 10 days in the Calendar since the latter was framed.

(The Calendar which has been supposed to be Meton's is given in Table IV.)

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June
I.	16	14	18	12	11	10	9	7	9	7	7	5
II.	5	3	2	2-31	30	29	28	26	28	26	26	24
III.	24	22	21	20	19	18	17	15	17	15	15	13
IV.	13	11	10	9	8	7	6	4	6	5	4	3
V.	2	1-30	29	28	27	26	25	23	25	23	23	21
VI.	21	19	18	17	16	15	14	12	14	12	12	10
VII.	10	8	7	6	5	4	3	2	3	2	1-31	29
VIII.	29	27	26	25	24	23	22	20	22	20	20	18
IX.	18	16	15	14	13	12	11	9	11	9	9	7
X.	7	5	4	3	2	1-31	30	28	30	28	28	26
XI.	26	24	23	22	21	20	19	17	19	17	17	15
XII.	15	13	12	11	10	9	8	6	8	6	6	4
XIII.	4	2	1	1-30	29	28	27	25	27	25	25	23
XIV.	23	21	20	19	18	17	16	14	16	14	14	12
XV.	12	10	9	8	7	6	5	3	5	4	3	2
XVI.	1-30	28	27	26	25	24	23	21	23	21	21	19
XVII.	19	17	16	15	14	13	12	10	12	10	10	8
XVIII.	8	6	5	4	3	2	1-31	—	1-31	29	29	27
XIX.	27	25	24	23	22	21	20	18	20	18	18	16

TABLE IV. CALENDAR SUPPOSED BY BOND TO HAVE BEEN METON'S.

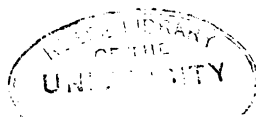
It appears to me to have been framed to be used with the Era of the Crucifixion (see p. 53) except that the epoch month must have been March or April instead of July. The Golden Number I has been applied to Meton's number XV to make it coincide with 83 A.D., which is the generally accepted date of the Crucifixion; and the moon accorded with the moon of this Calendar at, and for some time after, the commencement of the Christian Era, and not at the time of Meton. This is the only one of the three Calendars which has been adjusted approximately to the epoch of the Christian Era.

Meton's Numbers at the beginning of each year	—	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June
15	I.	13	11	10	9	8	7	6	4	6	5	4	3
16	II.	2	1-30	29	28	27	26	25	23	25	23	23	21
17	III.	21	19	18	17	16	15	14	12	14	12	12	10
18	IV.	10	8	7	6	5	4	3	2	3	2	1-31	29
19	V.	29	27	26	25	24	23	22	20	22	20	20	18
1	VI.	18	16	15	14	13	12	11	9	11	9	9	7
2	VII.	7	5	4	3	2	1-31	30	28	30	28	28	26
3	VIII.	26	24	23	22	21	20	19	17	19	17	17	15
4	IX.	15	13	12	11	10	9	8	6	8	6	6	4
5	X.	4	2	1	1-30	29	28	27	25	27	25	25	23
6	XI.	23	21	20	19	18	17	16	14	16	14	14	12
7	XII.	12	10	9	8	7	6	5	3	5	4	3	2
8	XIII.	1-30	28	27	26	25	24	23	21	23	21	21	19
9	XIV.	19	17	16	15	14	13	12	10	12	10	10	8
10	XV.	8	6	5	4	3	2	1-31	—	1-31	29	29	27
11	XVI.	27	25	24	23	22	21	20	18	20	18	18	16
12	XVII.	16	14	13	12	11	10	9	7	9	7	7	5
13	XVIII.	5	3	2	2-31	30	29	28	26	28	26	26	24
14	XIX.	24	22	21	20	19	18	17	15	17	15	15	13

TABLE V. CALENDAR FRAMED BY POPE HILARIUS FOR THE ERA OF CHRIST.

It is Meton's Calendar according to Table III., but made to commence on December 25 instead of July 16, and moved three years back in the true record of time, so as to make the Calendar Full Moon which occurs on Christmas Day coincide with the epoch of the era, December 25, 3 B.C. Astronomical (4 B.C. Vulgar). This Calendar (alluded to in Table II. as used in Saxon Charters) has never accorded with the moon.

Meton's Numbers at the beginning of each year		Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.
17	I.	10	9	7	9	7	7	5	5	3	2	2-31	30
18	II.	29	28	26	28	25	26	24	24	22	21	20	19
19	III.	18	17	15	17	15	15	13	13	11	10	9	8
1	IV.	7	6	4	6	5	4	3	2	1-30	29	28	27
2	V.	26	25	23	25	23	23	21	21	19	18	17	16
3	VI.	15	14	12	14	12	12	10	10	8	7	6	5
4	VII.	4	3	2	3	2	1-31	29	29	27	26	25	24
5	VIII.	23	22	20	22	20	20	18	18	16	15	14	13
6	IX.	12	11	9	11	9	9	7	7	5	4	3	2
7	X.	1-31	30	28	30	28	28	26	26	24	23	22	21
8	XI.	20	19	17	19	17	17	15	15	13	12	11	10
9	XII.	9	8	6	8	6	6	4	4	2	1	1-30	29
10	XIII.	28	27	25	27	25	25	23	23	21	20	19	18
11	XIV.	17	16	14	16	14	14	12	12	10	9	8	7
12	XV.	6	5	3	5	4	3	2	1-30	28	27	26	25
13	XVI.	24	23	21	23	21	21	19	19	17	16	15	14
14	XVII.	13	12	10	12	10	10	8	8	6	5	4	3
15	XVIII.	2	1-31	—	1-31	29	29	27	27	25	24	23	22
16	XIX.	21	20	18	20	18	18	16	16	14	13	12	11



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